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Systematic Studies of Asian *Aconitum* (Ranunculaceae) X. A New Species of Subgenus Aconitum from Yamagata Prefecture, Northern Japan, and the Second Locality of *A. iidemontanum* Kadota & al.

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Aconitum gassanense, a new species of subgenus Aconitum from Yamagata Prefecture, northern Japan, is here described. *Aconitum gassanense* belongs to Sect. Flagellaria (Steinb.) Nakai Ser. Latifolia Nakai with the chromosome number $2n = 2x = 16$ and is akin to *A. sanyoense* Nakai and *A. iidemontanum* Kadota & al. *Aconitum gassanense* is discriminated from *A. sanyoense* by having strigose pedicels and *A. iidemontanum* by having strigose pedicels and tall conical helmets with long beaks. *Aconitum iidemontanum* is reported from the same populations to *A. gassanense* in Mts. Gassan as the second locality of this species. Putative natural hybrids between *A. gassanense* and *A. iidemontanum* were also obtained from the populations. This is the first report of natural hybridization bewteen the species in the ser. Latifolia.

(Continued from Nat. Environ. Sci. Res. **15**: 1–7, 2003)

Key words: *Aconitum gassanense*, *Aconitum iidemontanum*, Mts. Gassan, new species, ploidy level.

In September, 2001, Mr. Shin'ei Kato kindly sent me living materials of *Aconitum* from the Gassan Mountains, Yamagata Prefecture, northern Honshu, Japan. The aconite is characterized by having membranous, medially trilobed leaves, tall conical helmets with long beaks, pedicels strigose with rough-surfaced curved hairs and carpels villose with a mixture of short, ascending smooth-surfaced hairs and also short, ascending smooth-surfaced glandular hairs. Later the chromosome number of the aconite was proved to be $2n=2x=16$ by Prof. Dr. T. Nishikawa, Asahikawa College, Hokkaido University of Education. The aconite is therefore a member of the diploid species group (e.g., Kadota 1984, 1987). As mentioned in those papers, the difference in ploidy level ($2n=2x=16$ vs. $2n=4x=32$) is an important diagnostic character in the classification of Japanese species of the genus *Aconitum* subgenus Aconitum.

Aconitum nipponicum Nakai subsp. *nipponicum* and *A. japonicum* Thunb. subsp. *subcuneatum* (Nakai) Kadota are hitherto known in the Mts. Gassan area, and both two taxa are members of the tetraploid species group and have the chromosome number of $2n=4x=32$ (Kadota 1984, 1987). The aconite has thus no relation to *A. nipponicum* subsp. *nipponicum* nor to *A. japonicum* subsp. *subcuneatum* from the view point of the difference in the ploidy level.

The aconite belongs to sect. Flagellaria (Steinb.) Nakai ser. Latifolia Nakai ex Kadota based on the gross morphology (membranous, medially trilobed cauline leaves, declining stem and attenuated nectary blades with long and slender spurs) and habitat (inhabiting in and along summer-green forests and scrubs of the subalpine to montane zone) as well as the ploidy level (diploid). Three species, *A. arcuatum* Maxim. (native to N. Korea and Far Eastern Russia), *A. iidemontanum* Kadota, Kita & Ueda and *A. sanyoense* Nakai are recognized in the ser. Latifolia until now (Kadota 1987, 1999). The aconite is characterized by having strigose pedicels and is significantly distinguished by the pedicel indumentum from *A. arcuatum* and *A. sanyoense* (both glabrous pedicels) and from *A. iidemontanum* (villose pedicels). In this way it is clear that the aconite in question should be treated as a distinct species in the ser. Latifolia.

In August, 2002, field examinations for *A. gassanense* were carried out in Mts. Gassan by the permission of the authorities concerned. At that time *A. iidemontanum* which is known only from the Iide Mountains, northern Honshu (Kadota 1999), was unexpectedly found out there for the first time. Simultaneously the presence of putative hybrids between *A. gassanense* and *A. iidemontanum* was also verified there. This is the first report of the natural hybridization between the species of the sect. Latifolia. The purposes of the present paper are to describe the aconite as a species new to the Japanese *Aconitum* flora, *A. gassanense*, and to report the Gassan Mountains as the second locality of *A. iidemontanum.*

Sect. **Flagellaria** (Steinb.) Nakai in Bull. Natn. Sci. Mus., Tokyo (32): 19 (1953).

Ser. **Latifolia** Nakai [in Bot. Mag. Tokyo **63**: 56 (1950), nom. invalid.; Bull. Natn. Sci. Mus., Tokyo (32): 48 (1953), pro subgen.] ex Kadota, Rev. Acon. E. Asia 49 (1987).

Aconitum gassanense Kadota & Shin'ei Kato, sp. nov. [Figs. 1–3]

Differt ab *Aconito sanyoensi* pedicellis strigosis; ab *A. iidemontano* pedicellis strigosi et cassidibus altis conicis cum rostris longis.

TYPE: JAPAN; Honshu, Yamagata Pref., Nishimurayama-gun, Nishikawa-machi, Mts. Gassan, Ishipane-sawa alt. 1160 m, 31 Aug. 2002, Y. Kadota 202210 (TNS–holotype).

Herbaceous perennial, 1–1.7 m high. Tubers carrot-shaped to obovoidal, 5 cm long, 1.5 cm in diameter; rhizomes abbreviated. Stem robust, straight, 8–12 mm in diameter in the distal part, declining, sparingly strigose in the distal part, much branched; branches ascending at an obtuse angle to stem and elongated. Leaves membranous, hemispherical in outline, light green on the adaxial side, glaucous on the abaxial side, glabrous on the adaxial side, strigose along veins on the abaxial side; midribs and lateral veins winged; radical and lower cauline leaves withering at anthesis; blades 11–18 cm wide, 10–12 cm long, medially 3-lobed to 3.5–5 cm from the base; middle lobes obovate rhombic to rhombic, acute, 2.5–5.5 cm wide, 6–8 cm long, coarsely dentate; lateral lobes distorted ovate, acute, 4.5–7.5 cm broad, 9–11 cm long, medially divided into two segments; apical teeth narrowly ovate to ovate, acuminate to acute, 6–10 mm wide; leaf bases cunetae to shallowly cordate; petioles 4–6.5 cm long, sparingly strigose. Inflorescence terminal in determinate condition, racemose, 3.5 cm wide, 7 cm long, 3–4-flowered, bracteate; bracts foliaceous but small, oblong. Pedicels arched, 3–4 cm long, longer than flowers, densely strigose with curved, rough-surfaced hairs throughout the surface, bi-bracteolate; bracteoles linear, 5 mm long, 1 mm wide, situated around the middle of the pedicels. Flowers bluish purple, ca. 3 cm high, sparingly strigose with

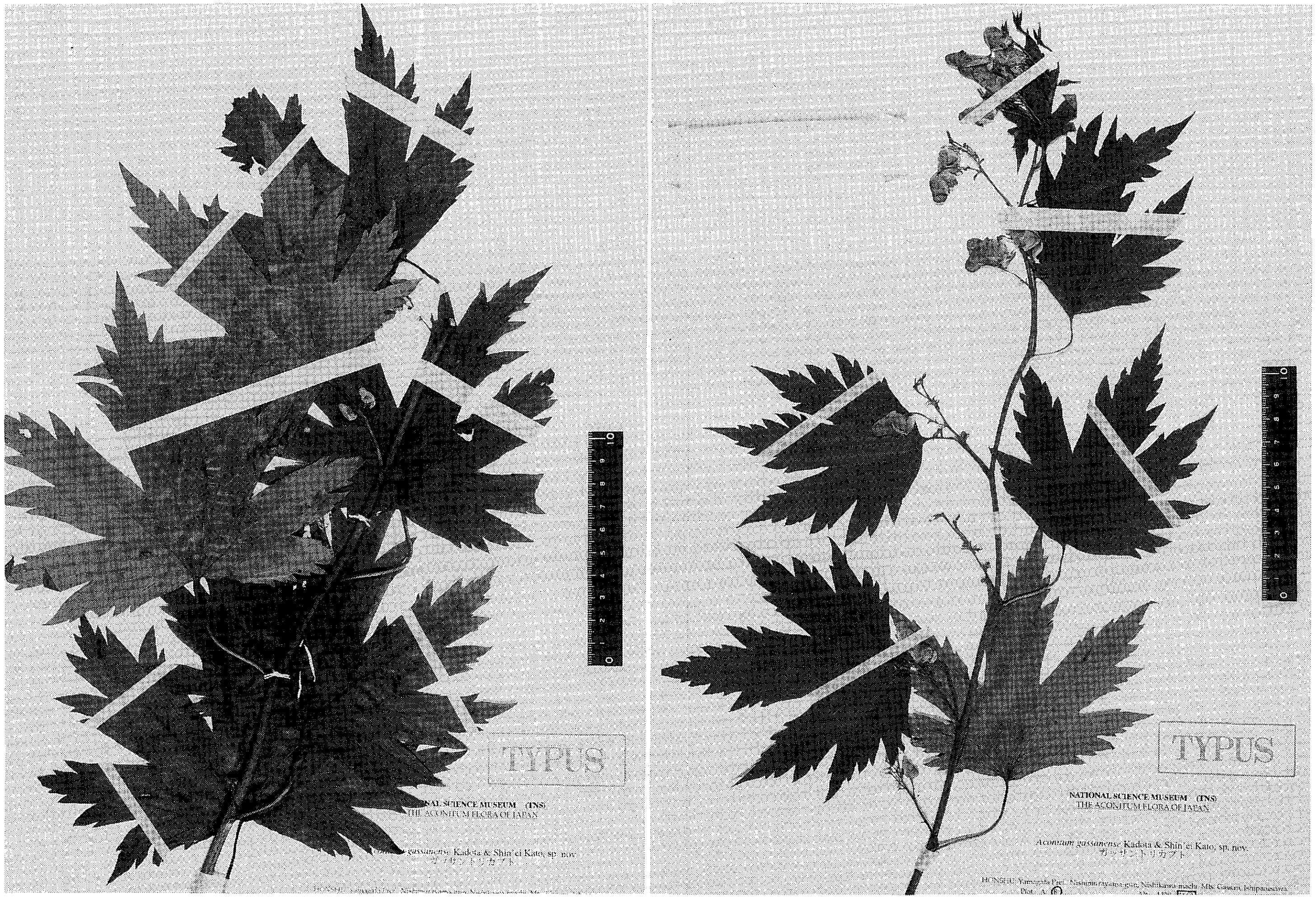
TYPUS
NATIONAL SCIENCE MUSEUM (TNS)
THE ACONITUM FLORA OF JAPAN
Aconitum gassanense Kadota & Shin'ei Kato, sp. nov.
TYPUS

Fig. 1. Type specimen of *Aconitum gassanense* Kadota & Shin'ei Kato (Kadota 202210, 31 Aug. 2002, Ishipanesawa alt. 1160 m, the Gassan Mountains, Nishikawa-machi, Nishimurayama-gun, Yamagata Pref., JAPAN; holotype–TNS). Right: Upper part. Left: Middle part.

rough-surfaced curved hairs; helmets hooded with horizontally projecting beaks and with concave lowers margins, 12 mm high, 15 mm wide, 21 mm tall; lateral sepals roundish, 12 mm long and wide, villose with long, straight and ascending, smooth-surfaced and rough-surfaced hairs on the adaxial side; lower sepals elliptic, obtuse, 4 mm wide, 10–12 mm long. Nectaries glabrous; blades attenuated to spurs, 3 mm wide, 8 mm long; labia ligulate, 2 mm long, bilobed, bluish purple, reflexed at apex; stipes gently incurved, 15 mm long; spurs deep purple, slender, long and hamately curved up to 360 degrees. Stamens sparsely villose with patent, smooth-surfaced hairs, dentate. Carpels 3, densely villose with short (0.5 mm long), smooth-surfaced, straight and ascending hairs and intermixed with short, smooth-surfaced ascending glandular hairs. Follicles ellipsoidal, 6 mm wide, 25 mm long, moe or less divergent, with recurved beaks (styles) ca. 5 mm long; seeds 5 mm long, trigonous, winged and lamellate across.

Jap. name: Gassan-torikabuto (nom. nov.).

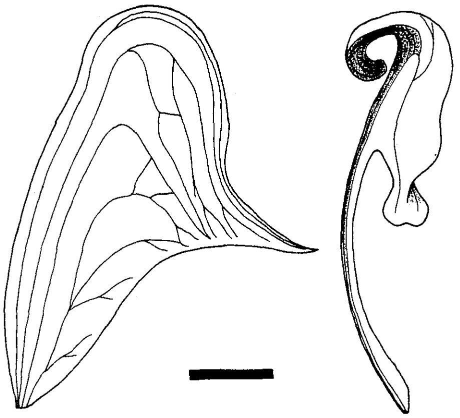

Fig. 2. Helmet (left) and nectary (right) of *Aconitum gassanense* Kadota & Shin'ei Kato (voucher specimen: S. Kato 01–46, 20 Sept. 2001, Ishipanesawa alt. ca. 1100 m, Mts. Gassan, Nishikawa-machi, Nishimurayama-gun, Yamagata Pref., JAPAN, TNS). Scale bar: 5 mm.

Chromosome number: 2n=2x=16 (Fig. 4).

Distr.: Gassan Mountains (Yamagata Pref.; Fig. 5). Endemic to the Gassan Mountains, Japan.

Other specimens examined: JAPAN; Honshu, Yamagata Pref., Nishimurayama-gun, Nishikawa-machi, the Gassan Mountains, Ishipane-sawa alt. 950–1000 m, 20 Sept. 2001, S. Kato 01-41-01-46 (TNS); Ishipanesawa alt. 1320 m, 31 Aug. 2002, Y. Kadota 202201–202208 (TNS)); Ishipanesawa alt. 1160 m, 31 Aug. 2002, Y. Kadota 202211–202216 (TNS).

Aconitum gassanense is related to *A. sanyoense* and *A. iidemontanum*. *Aconitum sanyoense* is distinguished from *A. gassanense* by having glabrous pedicels. *Aconitum iidemontanum* is discriminated from *A. gassanense* by having pedicels villose with smooth-surfaced patent hairs and smooth-surfaced glandular hairs and hooded helmets with short beaks.

The smooth-surfaced ascending hairs and the smooth-surfaced glandular hairs on carpels of *A. gassanense* are ca. 0.5 mm long and are shorter than those of *A. iidemontanum* and the members of the tetraploid species group (e.g., *A. senanense* Nakai and *A. jaluense* Kom. subsp. *iwatekense* (Nakai) Kadota; Kadota 1987). Such short smooth-surfaced hairs are found only on pedicels of *A. chiisanense* Nakai from South Korea and *A. longipetiolatum* Lauener and *A. palmatum* D.Don from the Himalayas.

In the realm of the Gassan Mountains, Yamagata Pref., northern Japan, the two kinds of aconites, *A. nipponicum* subsp. *nipponicum* and *A. japonicum* subsp. *subcuneatum*, are additionally reported besides *A. gassanense* (Kadota 1984, 1987). *Aconitum nipponicum* subsp. *nipponicum* grows in meadows of the alpine zone and the Gassan mountains are situated at the northern limit of the range of this aconite. While *A. japonicum* subsp. *subcuneatum* grows in and along summer-green forests of the basal zone. Both *A. nipponicum* subsp. *nipponicum* and *A. japonicum* subsp. *subcuneatum* have the chromosome number of 2n=4x=32 and

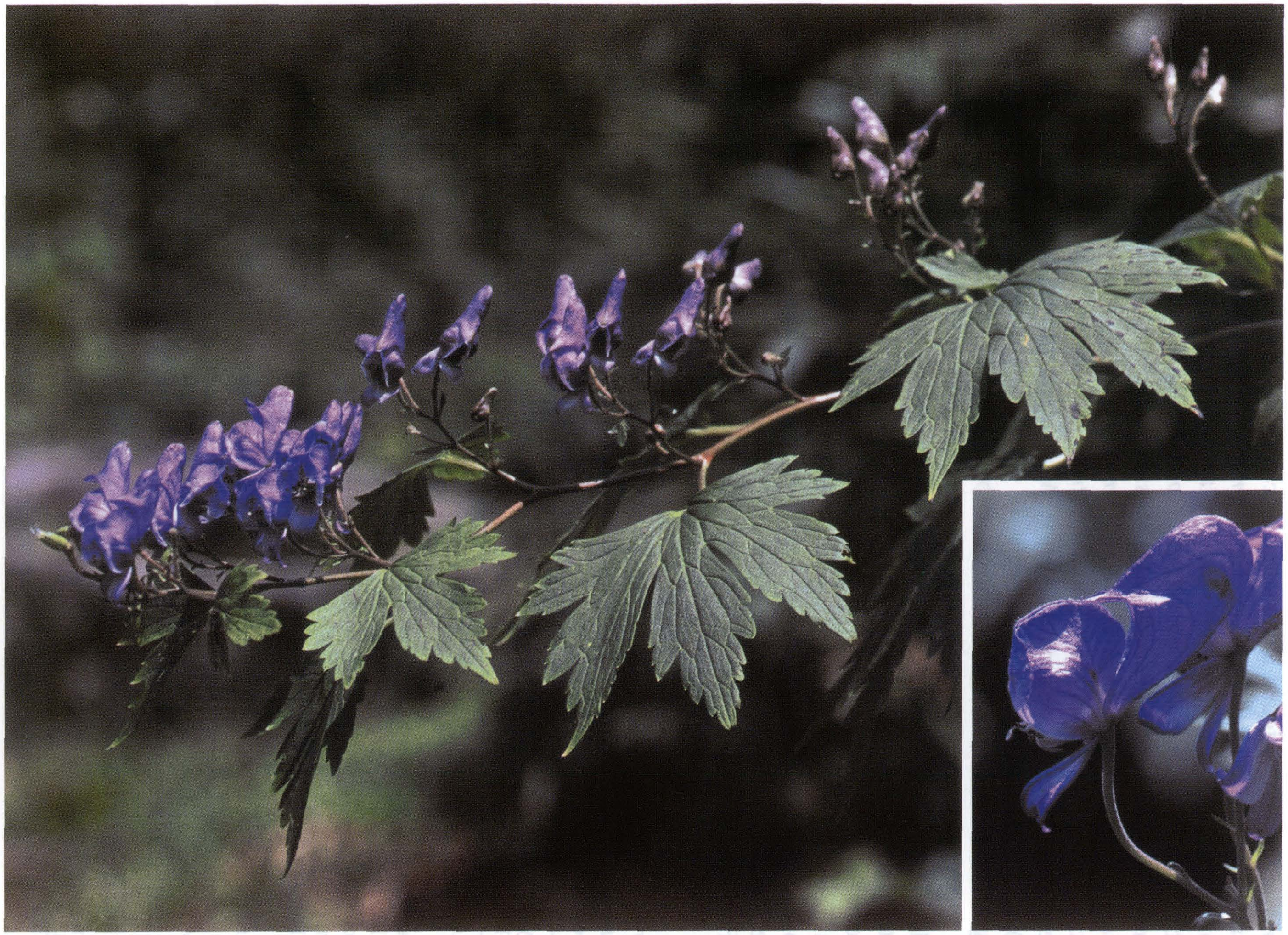

Fig. 3. Habit of *Aconitum gassanense* Kadota & Shin'ei Kato (31 August 2002, Ishipanesawa, alt. 1320 m, Mts. Gassan, Nishikawa-machi, Nishimurayama-gun, Yamagata Pref., JAPAN).

are members of the tetraploid species group (Kadota 1984, 1987). The diploid species, *A. gassanense* (Fig. 3), is found along summer-green forests of the montane zone. The habitat of *A. gassanense* is therefore sandwiched by those of *A. nipponicum* subsp. *nipponicum* (2n=4x=32) of higher sites and *A. japonicum* subsp. *subcuneatum* (2n=4x=32) of lower sites. Such a phenomenon is also observed in mountains of central Japan (Table 1).

In August, 2002, field examinations were executed in Mts. Gassan in order to observe habit and habitat of *A. gassanense*. Plants ascribable to *A. gassanense* were found in sites along streams ranging from 1000–1400 m in elevation. They were growing in subalpine tall herb stands and/or along margins of subalpine and montane summer-green scrubs. For example the vegetation of the type locality is the followings: shrub layer (2–3 m high)–*Swida controversa* (*Cornus controversa*), *Acer microphyllum*, *Sorbus matsumurana* and *Viburnum furcatum*; herb layer–*Reynoutria sachalinensis*, *Rodgersia podophylla*, *Cirsium ugoense*, *Sasa kurilensis*, *Thalictrum aquilegifolium* var. *intermedium*, *Aster glehni* var. *hondoensis*, *Veratrum stamineum*, *Clinopodium multicaule*, *Mitella pauciflora*, *Tiarella polyphylla*, etc.

In subalpine and montane habitats plants belonging to *A. iidemontanum* which is known only from the Iide Mountains, northern Honshu, were found out (e.g., Kadota 202217, TNS). This is the first report of *A. iidemontanum* outside of the Iide Mountains. Putative hybrids between *A. gassanense* and *A. iidemontanum* were also found there (Kadota 202209, 202218–202220, TNS). As already stated the two species, *A. gassanense*

Table 1. Vertical habitat segregation of the diploid species group and the tetraploid species group in the Japanese *Aconitum* (after Kadota 1987). The "sandwiched" structure of the *Aconitum* species is observed in the following mountains of the Honshu Island, Japan

Locality / zonation	the alpine zone	the montane zone	the basal zone
Ploidy level	2n=4x=32, tetraploid	2n=2x=16, diploid	2n=4x=32, tetraploid
Mts. Gassan	*A. nipponicum* ssp. *nipponicum*	*A. gassanense* *A. iidemontanum*	*A. japonicum* ssp. *subcuneatum*
Iide Mountains	*A. nipponicum* ssp. *nipponicum*	*A. iidemontanum*	*A. japonicum* ssp. *subcuneatum*
Mikuni Mountains	*A. zigzag* ssp. *kishidae*	*A. sanyoense**	*A. japonicum* ssp. *japonicum*
Hida Mountains (southern part)	*A. senanense* ssp. *paludicola*	*A. sanyoense*	*A. japonicum* ssp. *maritimum* *A. azumiense*
Mts. Hakusan	*A. nipponicum* ssp. *nipponicum* *A. ×hakusanense***	*A. sanyoense*	*A. zigzag* ssp. *ryohakuense*
Mts. Yatsugatake	*A. senanense* ssp. *senanense* *A. nipponicum* ssp. *micranthum*	*A. sanyoense*	*A. japonicum* ssp. *japonicum*
Mts. Norikuradake	*A. senanense* ssp. *paludicola* *A. nipponicum* ssp. *nipponicum* *A. zigzag* ssp. *zigzag*	*A. sanyoense*	*A. kiyomiense*
Akaishi Mountains (southern part)	*A. senanense* ssp. *senanense* *A. nipponicum* ssp. *micranthum*	*A. sanyoense*	*A. japonicum* ssp. *japonicum*
Kiso Mountains	*A. zigzag* ssp. *zigzag* *A. nipponicum* ssp. *micranthum*	*A. sanyoense*	*A. japonicum* ssp. *japonicum* *A. grossedentatum*

*A bulbiferous from of *A. sanyoense*. This form was originally described as a distinct species, *A. tonense* Nakai ex H.Hara.

**Plants belonging to *A. hakusanense* are ascribable to putative hybrids between *A. nipponicum* ssp. *nipponicum* and *A. zigzag* ssp. *ryohakuense* (Kadota 1986).

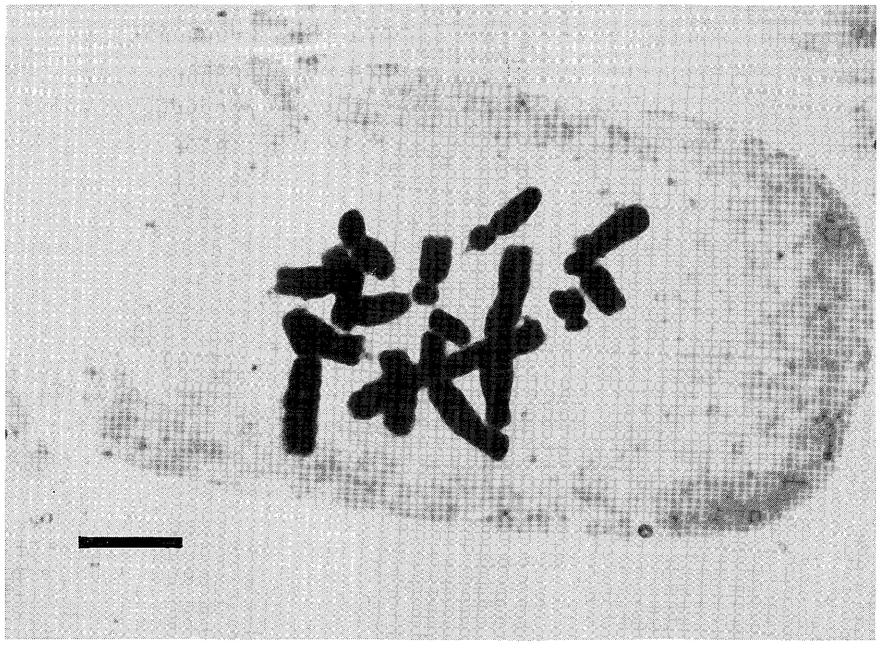

Fig. 4. Somatic chromosomes 2n=2x=16 of *Aconitum gassanense* Kadota & Shin'ei Kato (voucher specimen: S. Kato 01–46, 20 Sept. 2001, Ishipanesawa alt. ca. 1100 m, Mts. Gassan, Nishikawa-machi, Nishimurayama-gun, Yamagata Pref., JAPAN, TNS). Scale indicates 10 μm.

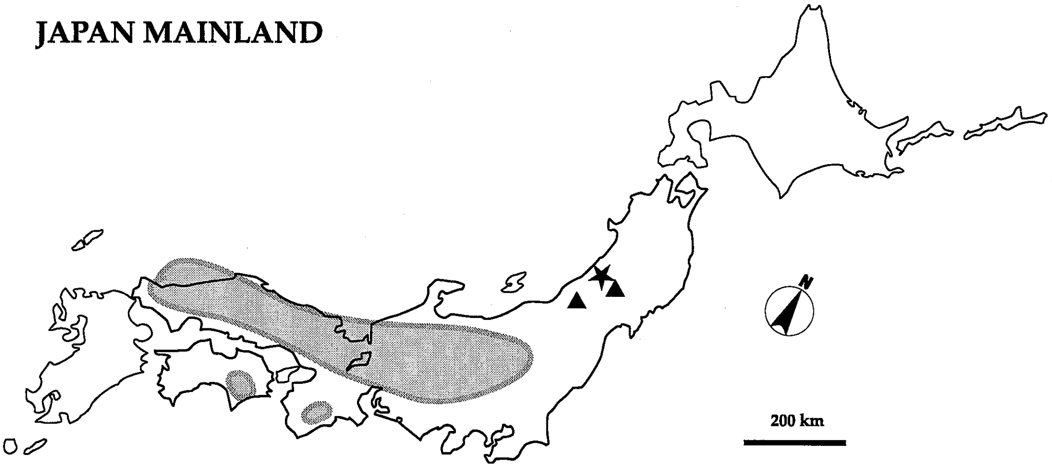

Fig. 5. Distributional ranges of *Aconitum gassanense* Kadota & Shin'ei Kato and its allied species. Star: *A. gassanense*. Triangle: *A. iidemontanum*. Dotted area: approximate range of *A. sanyoense*.

and *A. iidemontanum*, are clearly distinguished by the pedicel pubescence: *A. gassanense* and *A. iidemontannum* are characterized by strigose pedicels and villose pedicels, respectively. The putative hybrids have pedicels covered with the intermixed indumentum of rough-surfaced curved hairs, smooth-surfaced patent hairs and smooth-surfaced glandular hairs. This kind of pubescence shows hybridity of the species involved in natural hybridization (Kadota 1984, 1987). The hybridity is also confirmed through the artificial crossing experiments between *A. japonicum* subsp. *subcuneatum* with strigose pedicels and *A. okuyamae* with villose pedicels (Kadota unpubl.). This is the first report of the natural hybridization between the species of sect. Latifolia in the diploid species level.

I wish to show my sincere thanks to Prof. Dr. C.-W. Park, Seoul National University, for discussion on the *Aconitum* flora of Korea and Japan and the gift of Korean *Aconitum* specimens; to Mr. Shin'ei Kato for providing living materials of *Aconitum gassanense* and Messrs. Shin'ei Kato and Mikio Shida for guidance to the locality of this new species; to Prof. Dr. T. Nishikawa, Asahikawa College, Hokkaido University of Education for counting and taking pictures of the chromosomes of *A. gassanense*.

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門田裕一：アジア産トリカブト属植物の分類学的研究**X.** 山形県からのトリカブト亜属の**1**新種，ガッサントリカブト及びイイデトリカブトの第二の産地

山形県産のトリカブト亜属の1新種，ガッサントリカブト *Aconitum gassanense* Kadota & Shin'ei Kato を記載した．このトリカブトは月山山塊の固有種で，薄質で3中裂する茎葉，粗面屈毛が密生する花梗，短い滑面斜上毛と同じく短い滑面腺毛がはえる心皮を具えること，そして$2n=16$の染色体数をもつことで特徴付けられる．これらの特徴にもとづき，ガッサントリカブトはトリカブト亜属の中でツルカラフトブシ節 Sect. Flagellaria (Steinb.) Nakai サンヨウブシ列 Ser. Latifolia Nakai ex Kadota に所属することが明らかとなった．この列に属する日本産の種としては，このガッサントリカブトの他にサンヨウブシ *A. sanyoense* Nakai とイイデトリカブト *A. iidemontanum* Kadota & al. がある．サンヨウブシは無毛の花梗をもち，イイデトリカブトは滑面開出毛と滑面腺毛がはえる花梗をもつので，ガッサントリカブトとは明瞭に区別できる．ガッサントリカブトの心皮にはえる滑面斜上毛と滑面腺毛は長さ約0.5 mm とかなり短く，イイデトリカブトやセンウズモドキ *A. jaluense* Kom. subsp. *iwatekense* (Nakai) Kadota などの心皮や花梗にはえる滑面毛と滑面腺毛に比べて半分ほどの長さである．このように短い滑面毛と滑面腺毛は韓国産のチイサントリカブト *A. chiisanense* Nakai とヒマラヤ産の *A. longipetiolatum* Lauener と *A. palmatum* D.Don の花梗にのみ見られる特異なものである．

月山山塊ではトリカブト亜属の構成種として，本種の他に，ミヤマトリカブト *A. nipponicum* Nakai subsp. *nipponicum*（高山帯）とオクトリカブ

ト *A. japonicum* Thunb. subsp. *subcuneatum* (Nakai) Kadota（山地帯下部）の二つが知られている．これら2種類のトリカブトはともに2n=4x=32で4倍体種群の構成メンバーである．月山全体としては高所と低所にそれぞれ4倍体種のミヤマトリカブトとオクトリカブトが生育し，これらの二つに挟まれて2倍体種のガッサントリカブトが生育するという，「サンドウィッチ構造」を呈している．このような現象は構成メンバーを替えながら本州中部の山岳地帯でも観察されている (Table 1).

2002年8月に実施した月山における現地調査では，これまでに山形県飯豊山地にのみ知られていたイイデトリカブトが，ガッサントリカブトと同所的に生育することが見いだされた．月山はイイデトリカブトの第二の産地となる．さらに，同一の群落からこれらの2種の自然雑種形成によって生じたと考えられる個体の存在が観察された．サンヨウブシ列の複数の種が同所的に生育し，かつ両者の自然交雑に由来すると考えられる個体が得られたのはこれが初めての報告である．

（国立科学博物館植物研究部）